SEMI-ANNUAL REPORT
NASA CONTRACT NAS5-31368
FOR MODIS TEAM MEMBER STEVEN W. RUNNING
ASSOC. TEAM MEMBER RAMAKRISHNA R. NEMANI
SOFTWARE ENGINEER JOSEPH GLASSY
July 15, 1997

PRE-LAUNCH TASKS PROPOSED IN OUR CONTRACT OF DECEMBER 1991

We propose, during the pre-EOS phase to: (1) develop, with other MODIS Team Members, a means of discriminating different major biome types with NDVI and other AVHRR-based data. (2) develop a simple ecosystem process model for each of these biomes, BIOME-BGC (3) relate the seasonal trend of weekly composite NDVI to vegetation phenology and temperature limits to develop a satellite defined growing season for vegetation; and (4) define physiologically based energy to mass conversion factors for carbon and water for each biome.

Our final core at-launch product will be simplified, completely satellite driven biome specific models for net primary production. We will build these biome specific satellite driven algorithms using a family of simple ecosystem process models as calibration models, collectively called BIOME-BGC, and establish coordination with an existing network of ecological study sites in order to test and validate these products. Field datasets will then be available for both BIOME-BGC development and testing, use for algorithm developments of other MODIS Team Members, and ultimately be our first test point for MODIS land vegetation products upon launch. We will use field sites from the National Science Foundation Long-Term Ecological Research network, and develop Glacier National Park as a major site for intensive validation.

OBJECTIVES:

We have defined the following near-term objectives for our MODIS contract based on the long term objectives stated above:

-Organization of an EOS ground monitoring network with collaborating U.S. and international science agencies.
-Develop advanced logic for landcover classification using carbon cycle simulations from BIOME-BGC.
-Develop improved algorithms for estimating LAI and FPAR for different biome types from AVHRR data.
-Test of a generalized ecosystem process model, BIOME-BGC, for the simulation of the carbon, water and nitrogen cycles for different biomes.
-Implementation of the Global Ecological Simulation System (GESSys) to estimate continental net primary production (NPP) for the globe.
-Finish formal software engineering of our MODIS products, #14 Leaf Area Index and Fraction Absorbed Photosynthetically Active Radiation, and Daily Photosynthesis - Annual Net Primary Production, #16 and 17.

The NTSG lab currently employs the following members, who contribute to certain aspects of our MODIS work :

Dr. Steven Running, Director and Professor,
Dr. Ramakrishna Nemani, Research Assoc. Professor
Dr. Lloyd Queen, Associate Professor
Dr. John Kimball, Postdoctoral Research Associate
Dr. Kathy Hibbard, Postdoctoral Research Associate
Mr. Joseph Glassy, Software Engineer
Mr. Saxon Holbrook, Computer Systems engineer
Mr. Peter Thornton, PhD student
Ms. Galina Churkina, PhD student
Mr. Mike White, PhD student
Mr. Geoff Poole, PhD student
Ms. Alisa Keyser, PhD student
Mrs. Debra Kendall, Program Assistant

WORK ACCOMPLISHED:

Our core MODIS Team consists of SWRunning, Team Member, R. Nemani, Associate Team member, and Joe M. Glassy, Software Engineer. Dr. Lloyd Queen is being supported by MODIS funds to develop advanced regional scale resource applications from our standard MODIS products. The following will be reports on individual activities during this reporting period.

ACTIVITIES OF SWRunning - Team Member, January 1997 - July 1997,

EOS-IWG

As Chair of the EOS Land Science panel, SWRunning completed Chapter 7, Land Ecosystems and Hydrology for the EOS Science Plan. The text can be found at:

http://eospso.gsfc.nasa.gov/sci_plan/chapters.html

My central objective now is to organize a logical and efficient validation plan for EOS Land science, of which the MODLAND variables are central.

In a related activity, I served on the External Biennial Review team for Mission to Planet Earth. The report from that effort is pending.

EOS-NSF/LTER

A joint proposal to NASA and the National Science Foundation has been selected for start-up funding to explore sampling and instrument methodologies for measuring 3 MODIS core products, landcover, LAI and NPP over multi-hundred kilometer areas. This MODLER project brings together 14 Long-Term

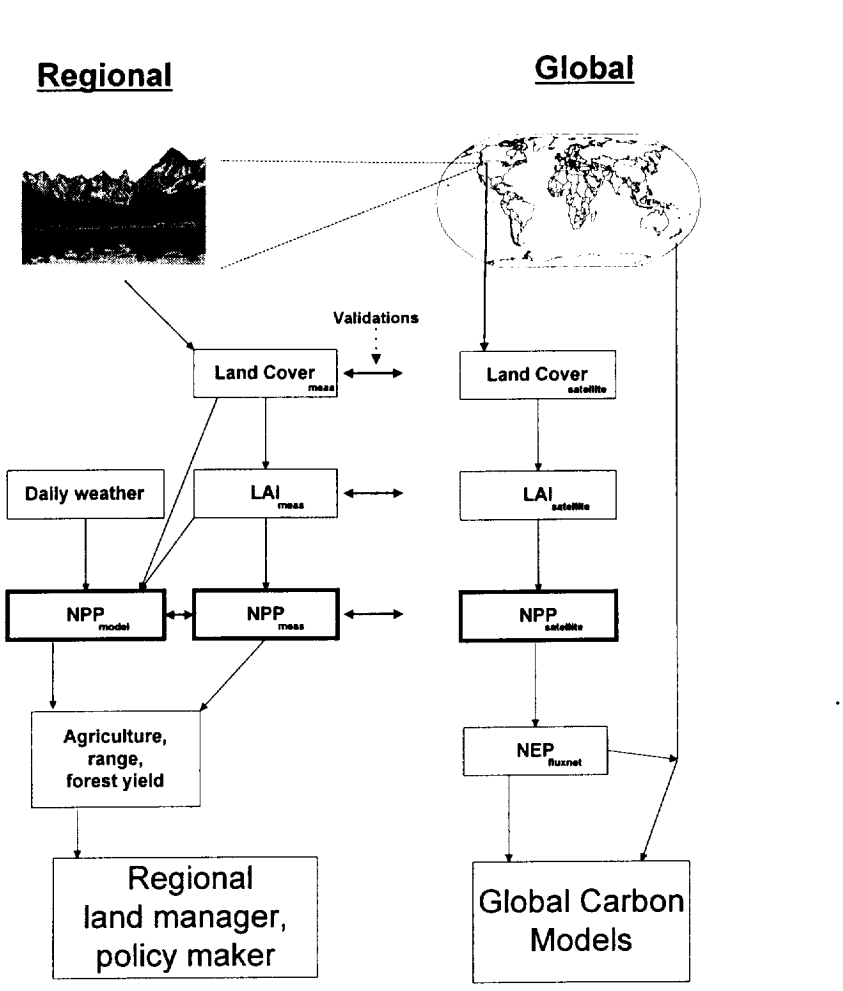
Ecological Research (LTER) Network sites and NASA's MODIS Land (MODLAND) Science Team for the purpose of locally validating Earth Observation System-era global data sets. Using several standardized methods that incorporate extensive ground data sets, ecosystem models, and remotely-sensed imagery, each LTER site is developing local maps of landcover class, leaf area index, and aboveground net primary productivity for a 100 km2 area at a grain size of 25 m. A nested, hierarchical ground-based sampling scheme will help establish error bounds on the variable estimates. A number of different strategies are being used to spatially aggregate the fine-grain site maps to a coarse grain (1 km) so that they can be compared to coincident portions of global maps of the same three biosphere variables developed by the MODLAND Science Team. The web site is at:

http://atlantic.evsc.virginia.edu/~jhp7e/modlers/

Full funding for this project was requested under the recent RFP for EOS Validation studies.

Global Climate and Terrestrial Observing Systems (GCOS/GTOS)

SWRunning attended an IGOS (Integrated Global Observing System) meeting in June 1997 to plan a strategy for synergism amongst the Global Climate and Terrestrial Observing Systems. The meeting, in Guernica, Spain ended with an agreement to use the MODLER protocol (see above) to organize a global network of sites taking compatible measurements of landcover, LAI and NPP over multi-kilometer scales. This network, now called GTOS-NPP will provide MODLAND with a very full sampling globally of these variables for validation. The project plan is diagramed below:



IGBP Biospheric Aspects of the Hydrologic Cycle (BAHC)

SWRunning is working with Drs Dennis Baldocchi and Ricardo Valentini concerned with organizing a global network of CO_2 and H_20 flux towers for continuous validation of MODLAND vegetation flux products. This network called FLUXNET, is based on the La Thuile, Italy workshop, and was published in Global Change Biology, in June 1996. We propose that FLUXNET will host the EOS Simple Tower configuration suggested in the MODLAND validation plan. A proposal to organize the network and archive office at the Oak Ridge DAAC was submitted to the EOS Validation program. The proposed network will be a combination of Ameriflux for North America:

(http://www.esd.ornl.gov/programs/NIGEC/),

EUROFLUX for Europe, OZFLUX for Australia/New Zealand, and other regions as they develop. ***I see FLUXNET and GTOS-NPP as the backbone of terrestrial vegetation validation for EOS.***

PIK NPP Workshop

The IGBP-GAIM project is running a global NPP model intercomparison at the Potsdam Institute for Climate change in Potsdam, Germany. This activity is the

most organized effort in the world to determine best NPP analysis for validating the MODLAND NPP product. The following two papers are ready for submission for summarizing and analyzing PIK-NPP results:

Churkina, G., SWRunning, A.Schloss and PIK-95 1997. Comparing global models of terrestrial NPP: The importance of water availability to primary productivity in global terrestrial models.

Churkina, G., and SWRunning. 1997. Contrasting climatic controls on the estimated productivity of different biomes.

VEMAP - Vegetation ecosystem modeling and analysis project

VEMAP is a project to intercompare leading biogeography and biogeochemistry models in the US for global change and EOS research programs. VEMAP has a homepage at:

http://www.cgd.ucar.edu:80/vemap/

The BIOME-BGC model that is part of our MODIS algorithm development for our NPP product is one of the three biogeochemistry models being tested.

GAP Analysis Project

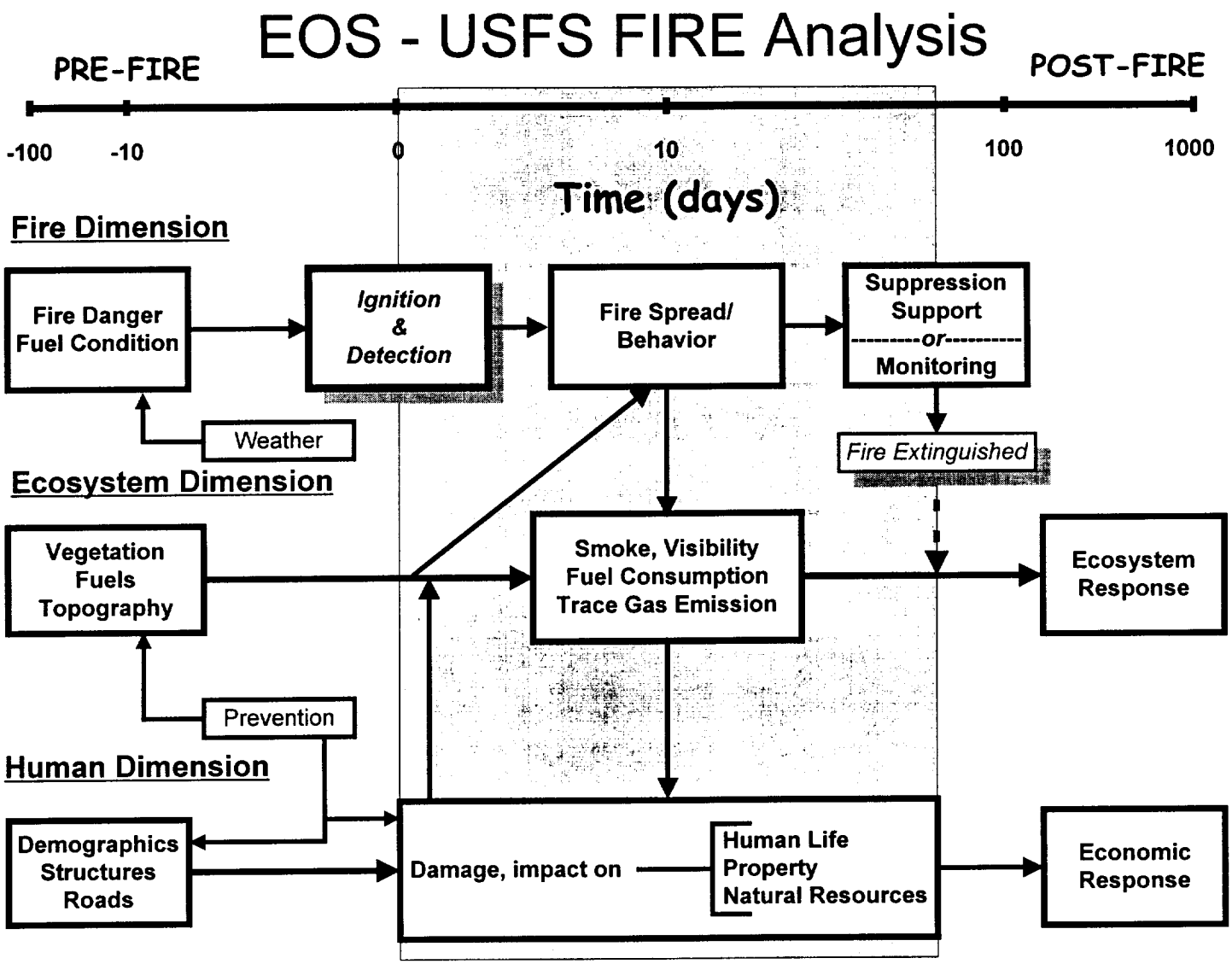
The GAP analysis project is a US National Biological Service funded project to map wildlife habitat in each state using high resolution satellite imagery. Their homepage is at:

http://www.gap.uidaho.edu/gap/

I am working with the national GAP office about sharing their database with the MODLAND team to use as a validation source for our Landcover algorithm. Details of this agreement are being developed.

EOS – US Forest Service Fire Management project

I have worked with the US Forest Service Intermountain Fire Research Lab for the last year to design a plan to incorporate EOS data into a next generation Wildfire Management Plan. These ideas were presented at the EOS-IWG meeting in San Diego in February. The current project outline is given below:



The Fire Lab is currently preparing a detailed implementation plan for this project. Meanwhile, we are testing one component, the satellite derived fire danger mapping. Lloyd Queen reports on that activity in his section below.

SWRunning attended the following NASA EOS MEETINGS

EOS-SEC Meetings February, April 1997
MODIS Science Team Meeting May 1997
MTPE Biennial Review, June 1997
NASA Boreas workshop, March 1997
NASA Interannual Variability workshop, March 1997

PUBLICATIONS

White,M.A., Thornton, P.E., and S.W. Running. (1997). A continental phenology model for monitoring vegetation rewsponses to interannual climatic variability. *Global Biogeochemical Cycles* **11(2):** 217-234.

Running, S.W. , Nemani and Glassy. 1997. Global Net Photosynthesis and Tterrestrial Net Primary Productivity From The Earth Observing System, to appear in Methods in Ecosystem Science, edited by Sala, Jackson, Mooney and Howarth, Springer-Verlag New York, Inc.

Waring, R.H. and S.W.Running 1997. Forest Ecosystems: Analysis at Multiple Scales. Academic Press. (in press).

MODLAND ACTIVITIES of R. NEMANI

WORK ACCOMPLISHED

Climate change and Vegetation response:

1. Greening of Northern High latitudes

   Variations in the amplitude and timing of the seasonal cycle of atmospheric CO_2 have shown an association with surface air temperature consistent with the hypothesis that warmer temperatures have promoted increases in plant growth in the northern high latitudes. We present evidence from satellite data that the photosynthetic activity of terrestrial vegetation increased from 1981 to 1991 in a manner suggesting an increase in plant growth associated with an increase in the duration of the active growing season.

   The regions of greatest increase lie between 45°N and 70°N where marked warming has occurred in the spring time2 due to an early disappearance of snow.3 The satellite data are concordant with an increase in amplitude of the seasonal cycle of atmospheric carbon dioxide exceeding 20% since the early 1970s, and an advance in the timing of the drawdown of CO_2 in spring and early summer of up to 7 days.1 Thus, both the satellite data and the CO_2 record indicate that the global carbon cycle has responded to interannual fluctuations in temperature which, although small at the global scale, are regionally highly significant.

2. Response of Austrian forests to changes in climate

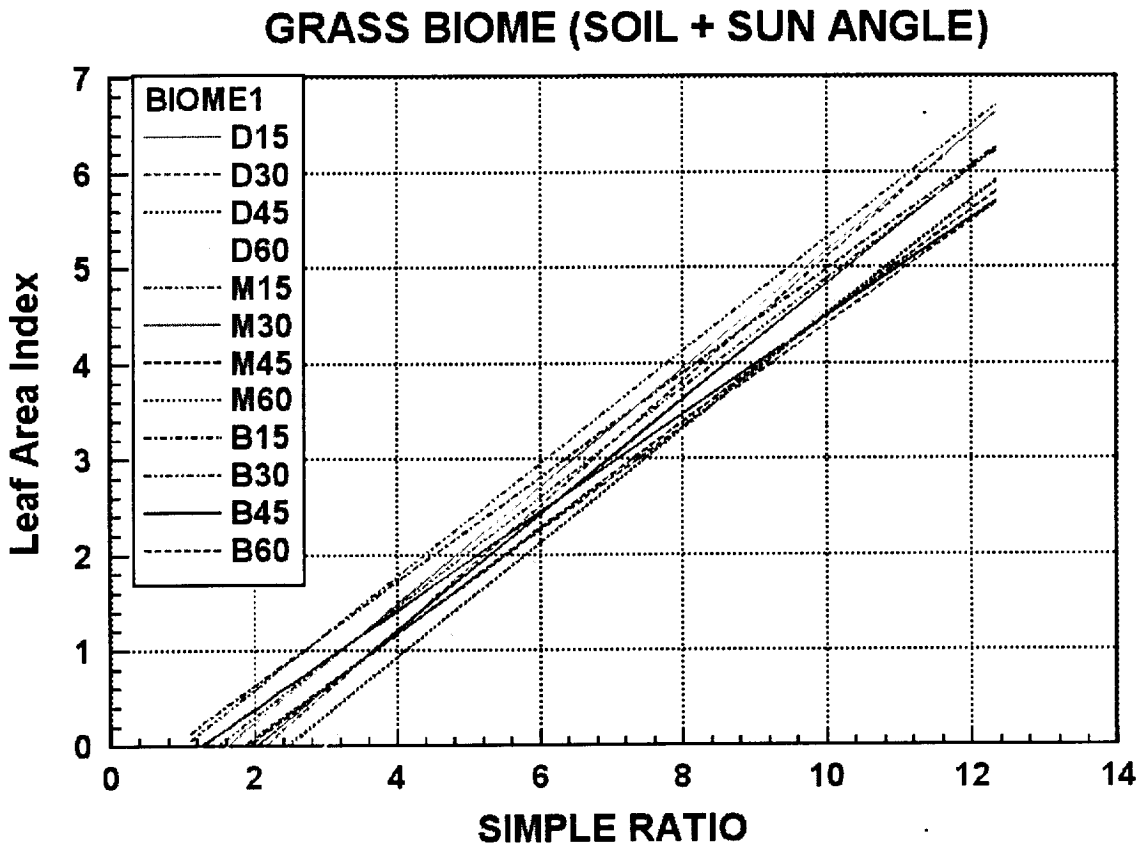
The purpose of this study is to explore if changes in climate could have caused the increased increment rates reported for European forests, specifically in Austria. Using 30 years of climate records from 20 weather stations in Austria, we investigated the magnitudes of temperature changes and the change in length of the growing season between 1961-1990. Special attention was paid to the period between 1981-90 over which forestry observations were available. In order to understand the significance of changes in climate on forest growth, we used the ecosystem model,FOREST-BGC, to predict annual net primary production.

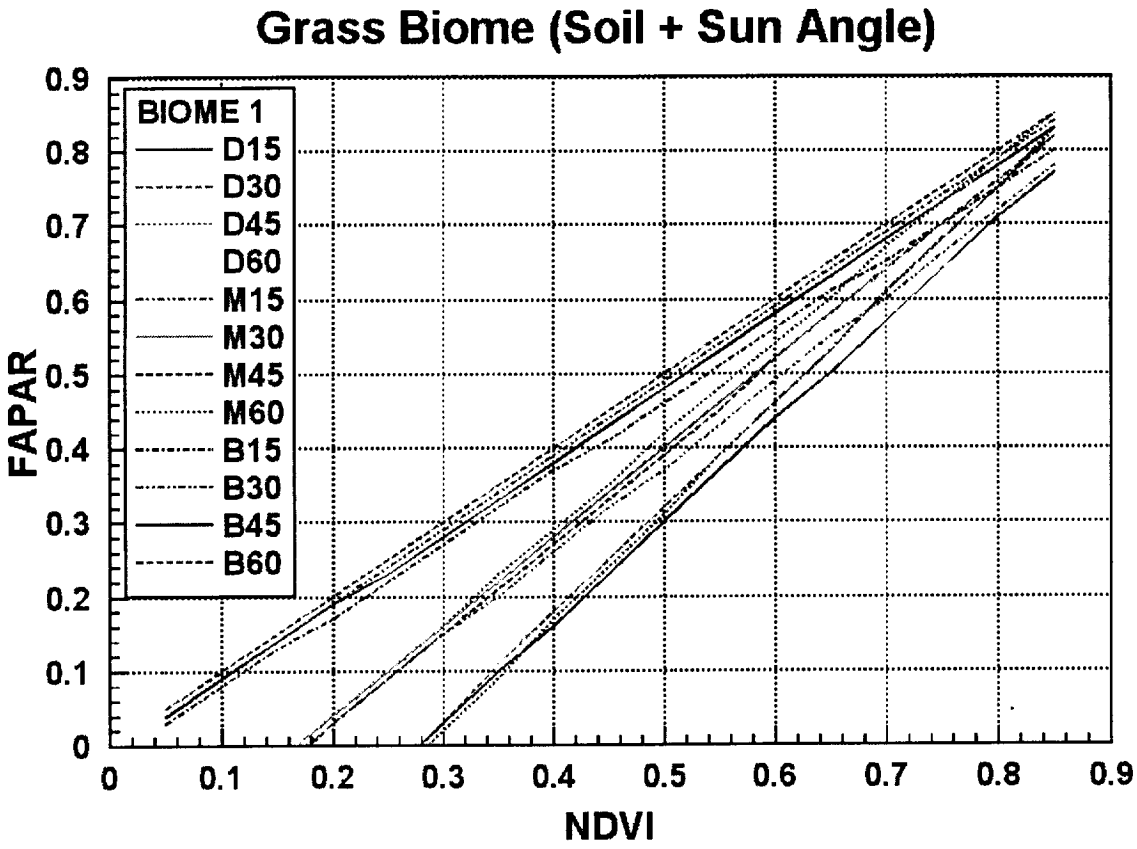
The results indicate: (1) no change in precipitation over the period; (2) an average temperature increase of 0.7 C between 1981-90 vs. 0.2 between 1961- 1980; (3) length of growing season increased by 21 days between 1981-1990; (4) net primary production increased by 11% between 1981-90 and only 0.6% between 1961-1980. The trends in NPP are consistent with observed diameter increment rates determined from 614 increment cores of Norway Spruce distributed all over Austria.

MODIS Algorithms

Leaf Area Index/fAPAR

Following our earlier work (to be published in IEEE Trans. Geoscience and Remote Sensing) on the back-up algorithm, we further refined the empirical relationships to account for variations in soil background, view angle, sun angle. Aproximately 400 relationships each have been developed for LAI and FPAR for the six biomes. The sun and view angle dependent relationships help in better estimation of LAI and FPAR. Our earlier NDVI based relations have been modified to use SIMPLE RATIO for estimating LAI. The SR based relations are found to be linear over much of the observed range (0-6) of LAI for different biomes. The following examples show variations in the relationships between NDVI and fAPAR and SR and LAI for grass biome for various combinations of soil (Dark, Medium, Bright), and sun angles (15-60).


GRASS BIOME (SOIL + SUN ANGLE)
BIOME1
D15
D30
D45
D60
M15
M30
M45
M60
B15
B30
B45
B60
Leaf Area Index
SIMPLE RATIO
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14



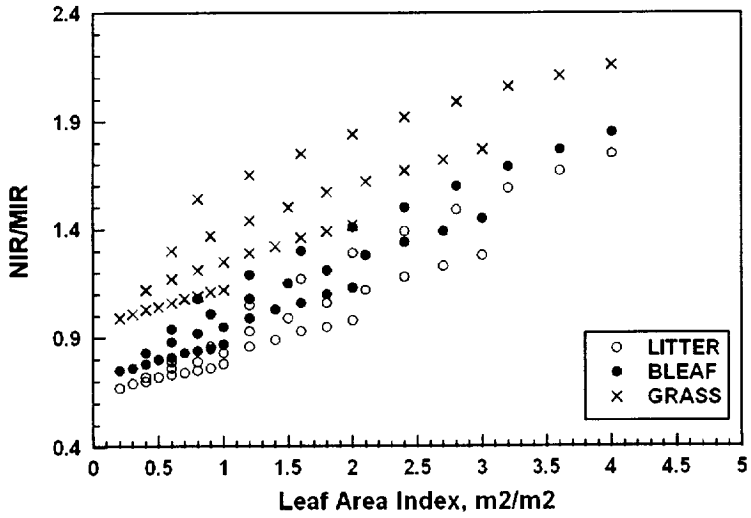
Net Primary Production

The Production Efficiency based model is simplified and streamlined to use currently available datasets from DAO. A number of decisions had to be made on the use of several variables produced by the DAO, the most important one being the use of variables produced at 10m instead of 2m height. This decision has significant influence on NPP estimates over low canopies such as grasses and crops. The DAO does not have much confidence on their estimates at 2m height.

Role of Mid-IR in vegetation studies

Several studies over the past 15 years have shown the utility of MIR wavelength band for quantifying vegetation type and density. Negligible impact of the atmosphere on MIR, and high contrast between soil and vegetation allow MIR measurements to be extremely useful for land cover classification, and for deforestation studies. Since MODIS carries a MIR band, we would like to use this information to strengthen our LAI/FPAR algorithm.

Using 3-D radiative transfer model, we simulated the response of several canopies with varying backgrounds in terms of MIR response. Results were quite promising as relationships between NIR/MIR have significantly changed depending on the background type, as shown below.

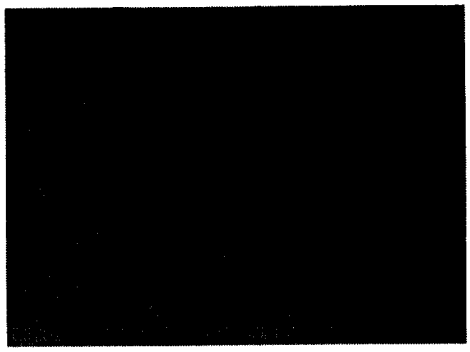


Validation of MODIS products

Jornada PROVE

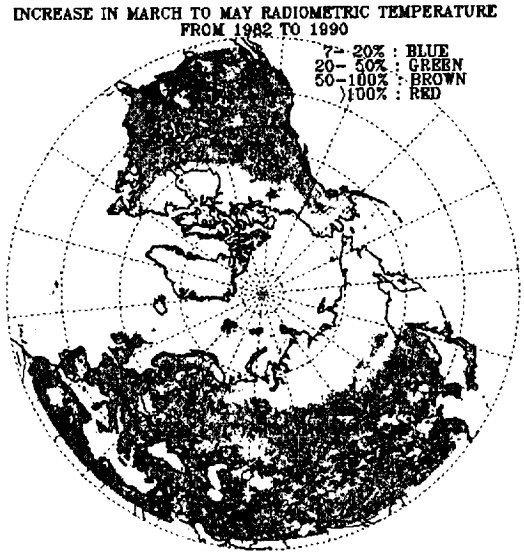
A first test of MODLAND Lai/fAPAR algorithm was attempted at the Jornada Experimental Station. The study site was an extremely sparse shrubland. Over a three day period, we collected LAI and fPAR measurements, using several instruments. We also tested a new digital camera that records radiation at NIR and Red wavelengths. The extremely portable imager is easy to use and the software allows one to compute various indices. Examples of the images taken by the digital camera are shown below.

WORK IN PROGRESS



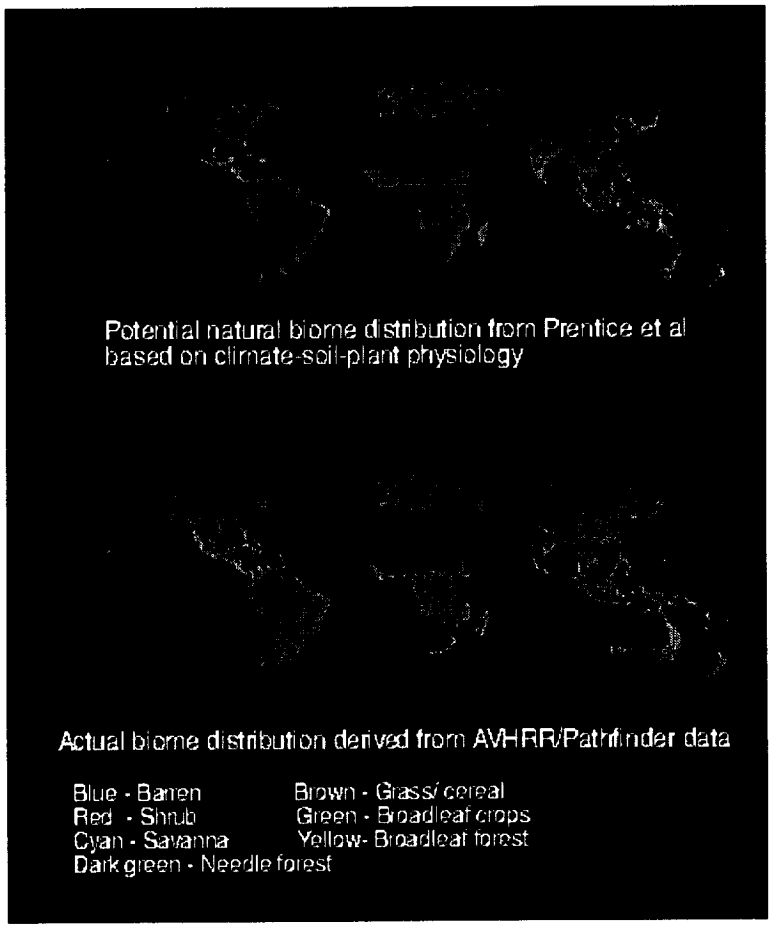
Inter-annual variations in Ts/NDVI

This study follows our earlier work on the inter-annual variations in NDVI over the northern hemisphere. In this case, we study the spatial correlation between AVHRR surface temperature and NDVI. Though both measures were collected simultaneously, they carry complementary information about the surface processes. An increase in Ts should help in better growth conditions for plants in the high latitudes, as temperature is the main limiting factor for growth. Therefore, a study involving both Ts and NDVI would help in better understanding of the processes that lead to higher plant growth.



Land cover changes and their impact on climate

Our earlier work on land cover changes concentrated solely on defining change based on density of vegetation. Having completed our 8km satellite based land cover classification, we wanted to study changes in fluxes in terms of their timing and magnitude. The 14 year pathfinder dataset would be used to study changes in absorbed radiation and surface temperature between potential and actual vegetation.



Validation of LAI algorithm

Participation in the FOREST-PROVE to be conducted at Oakridge National Lab in August. A manuscript is also being prepared testing the LAI/FPAR algorithm over conifer forests, for the special edition of RSE (MODELERS).

MEETINGS ATTENDED

Feb 1997 MODIS/SDST meeting, GSFC/Greenbelt
May 1997: MODIS Science meeting, Greenbelt

PUBLICATIONS

Nemani,R.R. and S.W.Running. (1997). Landcover characterization using multi-temporal red, near-IR and thermal-IR data from NOAA/AVHRR. *Ecological Applications* **7(1):** 79-90.

Myneni, R.B., C.D. Keeling, C.J. Tucker, G. Asrar and R.R. Nemani. 1997. Increase plant growth in the northern high latitudes from 1981-1991. *Nature* (April 17), 386: 698-702.

Kimball, J., S.W. Running, and R. Nemani. (1997). An improved method for estimating surface humidity from daily minimum temperature. *Agricultural and Forest Meteorology* (in press)

Myneni, R.B., Nemani, R.R., and Running, S.W. (1997). Algorithm for the estimation of global land cover, LAI, and FPAR based on radiative transfer models. *IEEE Trans. Geoscience and Remote Sensing.* (in press).

White, J.D., S.W. Running, R.Nemani, R.E. Keane, and K.C. Ryan. (1997). Measurement and mapping of LAI in Rocky Mountain Montana Ecosystems. *Canadian Journal of Forest Research* (in review).

Hasenauer, H., R. Nemani, K. Schadauer and S. Running. 1997. Forest growth response to change climate between 196-1990 in Austria. Forest Ecology and Management (submitted).

ACTIVITIES OF J. M.Glassy, MODIS Software Engineer: July, 1997

OBJECTIVES

My objectives during the time period February 1997 to July 1997 were to:

1) Complete delivery of the MOD_PR15 V1 software codes
2) Continue development of a in-house MOD_PR17 code suite

3) Commence development of the MOD_PR15 and MOD_PR17 codes for V2
4) Continue various data development tasks relating to algorithm development and test.
5) Oversee the evolution of the local NTSG laboratory MODIS Compute Ring Facility (MCR)
6) Participate at various NASA MODIS meetings, track the evolution of key MODIS project documents, and track MODIS email traffic for issues relevant to our involvement.

WORK ACCOMPLISHED

MOD15: FPAR/LAI Product

The V1 codes for the MOD_PR15A2 codes were initially delivered April 21, 1997 to the SDST. A number of post delivery integration issues then arose which over time were summarily resolved, with baselining to the MODIS Configuration Manager of the MOD_PR15A2 codes accomplished by early July, 1997. Robert Wolfe delivered the V1 codes for MOD_PR15A1, the pre-processor for the MOD15 algorithm, early April 1997, followed by an official file spec.

The dominant activity during this period focused on implementing a number of minor code revisions to bring our codes into full compliance with MODIS standards and conventions. In addition, several minor corrections were required to eliminate heap memory leaks from our software operating in the SGI verification environment. Principal challenges included keeping up frequent changes to the evolving EOSDIS core system metadata and HDF-EOS standard. A new version of the Science Data Production Tookit (SDPTK), version 5.2, was downloaded and successfully built on the IBM RS/6000 AIX 4.1 environment. A new version of the HDF-EOS library, version 2.0, was also downloaded from the eos.hitc.com server and built on the AIX 4.1 environment. The correct functioning of these libraries on this platform is now being evaluated during the summer 1997 period, as part of our routine code development.

Major V2 code development activities during this period included participation with the Boston University and Arizona University groupd in the formulation of a new cross-product common 1KM surface reflectance file specification, initially based on the aggegration code originally developed as part of the MOD43 product. The V2 file spec is now complete, has been agreed upon by all parties, and a test data generation software utility (gendata.c) from Boston University has been made available for the purpose of constructing new HDF-EOS format test V2 compliant datasets. Minor changes are still expected in the implementation of this data set.

MOD17: PSN/NPP Product

On the MOD17 algorithm, coding towards an in-house version 1.5 generation, as well as the formal V2 generation is progressing. Several design re-evaluations were conducted, for the purpose of assuring the software would run as economically as possible in a potentially resource constrained EOSDIS environment. The first test generation of an HDF-EOS format DAO global surface climatology dataset was downloaded from the DAO during this period, with evaluation of this data now progressing. Problems due to modeled canopy roughness near the surface in the 2-meter family of assimilated fields for near surface temperature and absolute humidity persist in this test data set, requiring us to adopt the use of "nearest equivalent" 10-meter fields which do not suffer from these problems. In addition, we began construction of a 3D static fallback global surface climatology dataset, to be triggered by a runtime production rule indicating failure of DAO data availability. Coding continues on the three main PSN, NPP software modules making of the MOD17 suite: ***clim_psn***, (for temporal aggregation of the DAO climate database), ***psn_npp*** (the main net primary productivity algorithm), and ***aggr_psn*** (the post-processor for spatially degenerating the 1KM outputs to the coarse geographic projection climate modeling grid).

Evolution of the MODIS-University of Montana (MUM) API software library

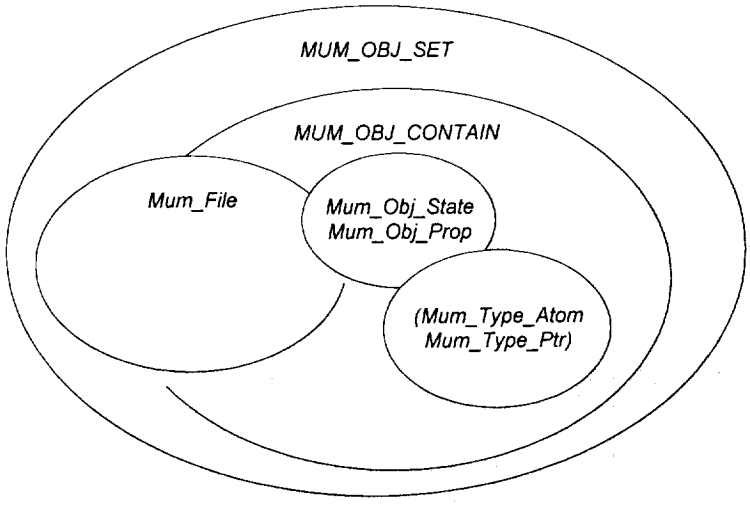
The multi-platform MUM API library is now at version 1.06.8, and has achieved the developmental milestone of having been baselined by the MODIS CM at version 1.06.4 as part of the MOD_PR15A2 V1 delivery. Support for standard HDF 4.1 data objects is complete, with incremental performance improvements have been made across the board. The MUM API now consists of 27569 lines of code (LOC) across 240 functions in version 1.06.8. This API library has been successfully ported to the following UNIX compute environments: IBM AIX 4.1, SGI IRIX v.6.4, DEC Unix v.3.2. On the Intel architecture, the MUM API library has been ported to Linux v. 2.0.x, and Microsoft NT version 4.0. The MUM API's full NASA PGS compatibility mode is only supported for workstation environments the SDPTK is ported to. The more general SCF mode is supported across all port platforms.

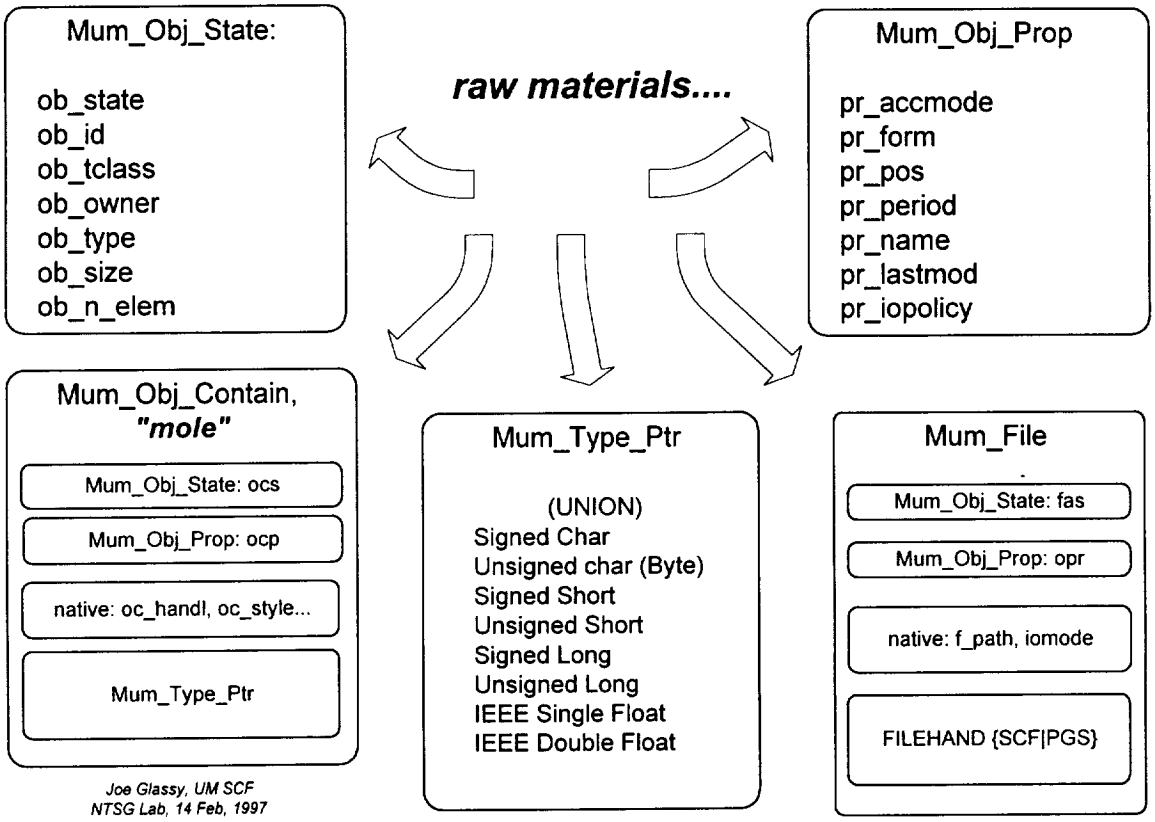
For internal SCF purposes, a revised distributed software compute scheme (Montana Nested Cluster) considerable progress has been made in the implementation of the POSIX thread component of the MNC execution model. A part time assistant programmer, Peter Votava, has implemented a fairly generalized, multi-thread workpile software template, with initial testing conducted using several in-house MUM client applications. Ultimately we hope to use the MNC scheme to distribute large compute tasks over a set of network connected hosts.

Documentation enhancements for the MUM API software include the following

data model diagram, which illustrates the basic relationships between major MUM API data objects:

MODIS -- University of Montana (MUM) API
Data Object Model





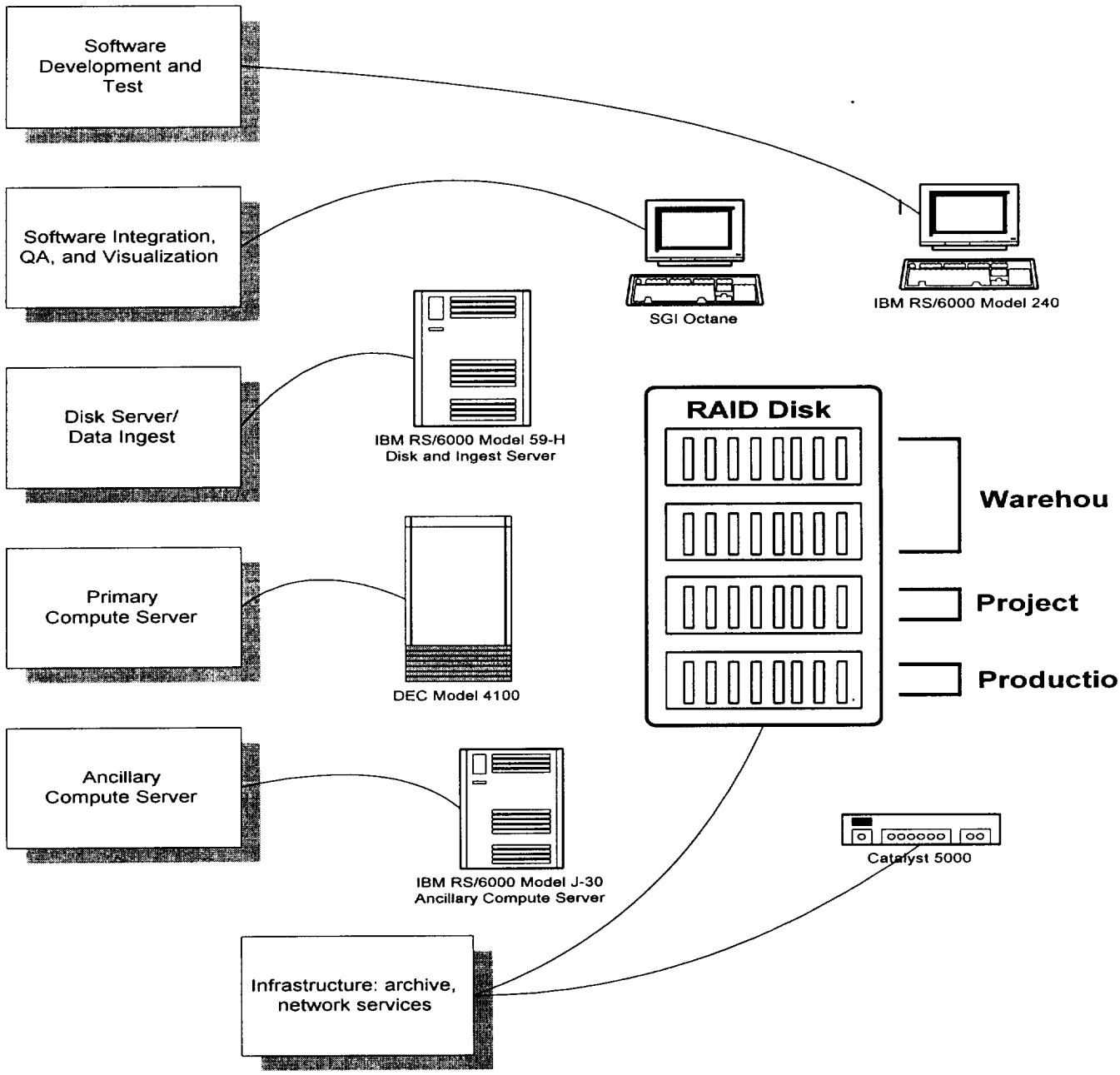
Joe Glassy, UM SCF
NTSG Lab, 14 Feb, 1997

MODIS Compute Ring (MCR) at the University of Montana SCF

During this period, we experienced major growth areas in our MODIS Compute Ring Facility (MCR). We ordered and installed the next complement of RAID 0/3/5 rack mounted fixed disk, adding 127G to our existing store, for a current total of approximately 210G of on-line RAID. Evolution of the MCR during this period was guided by the next generation of our MCR Plan, which further clarified the functional roles and responsibilities of all workstation, disk and near on-line tape hardware elements. Within this plan we detail a formal scheme for organizing the large capacity RAID stores, into warehouse, project, and production data subsets. Under this plan, each workstation component will maintain a primary attach point to a RAID segment base on its functional role. The IBM RS/6000 Model 59-H workstation has now been given the key role of MCR disk server as well as primary ingest duties handling initial entry of majory data sets from off-site. Our IBM RS/6000 Model J-30, an 8-way SMP computer, is now focused on general compute services.

The Montana SCF MCR functional roles are illustrated in the following diagram, as mapped to major facility components:

Montana SCF
MODIS Compute Ring Facility:
Functional Roles for
Major Components



New Montana SCF Hardware Components

A new SGI workstation has been added for MODIS software integration, QA, and test, to closely mirror hardware compatibility at the GSFC TLCF. QA and test activity is expected to benefit greatly from this the high performance and visualization capabilities on the Octane. The SGI Octane workstation is a state of the art entry level 2-way SMP workstation driven by 64bit MIPS R10000 CPUs, identical to those in the SGI Power Challenges and Origin 2000's deployed at the TLCF. Our SGI Octane runs under the SGI IRIX v.6.4 operating system in either 64 or 32 bit mode, using identical compiler suite to the TLCF. It is our hope that the late-cycle SDPTK integration problems due to slight incompatibilities on the IBM platform will be resolved with this environment.

A state of the art Digital Equipment Corporation (DEC) Model 4100 Alpha rack mount workstation has also been ordered and is expected to ship in mid-July 1997. This workstation runs Digital Unix v.4.2 and will take on the role of principal MCR compute server, equipped with (3) Alpha 64 bit 21164 CPUs running at 446mhz and 1G of core memory. The DEC 4100 with have a primary RAID attach point to the production RAID volumes. The IBM RS/6000 Model J-30 SMP 8-way workstation will continue in the role of ancillary compute server.

In addition to the SGI and DEC workstations, an IBM RS/6000 Model 32P/240 2-way SMP workstation now replaces the IBM RS/6000 Model 41T used for primary software development. For high capacity near on-line data archive management, a rack-mounted 30 cartridge 1 TB MPI 4mm DLT tape robot has been added, to coordinate extern data ingest activity, as well as serving large dataset archive for both R&D and production model runs.

For internal SCF purposes, a revised distributed software compute scheme (Montana Nested Cluster) considerable progress has been made in the implementation of the POSIX thread component of the MNC execution model. A part time assistant programmer, Peter Votava, has implemented a fairly generalized, multi-thread workpile software template, with initial testing conducted using several in-house MUM client applications. Ultimately we hope to use the MNC scheme to distribute large compute tasks over a set of network connected hosts.

MEETINGS ATTENDED

MODLAND/SDST Workshop, February 17-21, 1997
V1 software integration site visit to TLCF, March 29-April 4 1997
MODIS Science Team Meeting, May 14-16, 1997

ON GOING ACTIVITIES

Algorithm Development

During the next period we will concentrate on a number of algorithm issues. These include integration of the FPAR, LAI (MOD_PR15) codes to the new HDF-EOS library, integration of new improvements from team member Ranga Myneni of Boston University, culminating on a V2 delivery for both MOD_PR15 and MOD_PR17 codes. Relating to these software development issues is the on-going refinement in our SCF QA plan, as it relates to the MODIS land QA plan as a whole.

Data Development

Test data development activities in the next period will include producing and testing more realistic, robust MODIS like surface reflectance datasets, that include full instances of conforming ECS metadata, in HDF-EOS format. There are a number of quality verification tasks also to perform, including an on-going assessment of the DAO global daily surface climatology data, and exploring refinements in the way these coarse spatial data are interpolated to the MODIS 1KM integerized sinusoidal (IS) grid.

MODIS UM SCF Compute Ring Infrastructure

In the next period, we are planning on acquiring more RAID on-line disk, performing a series of minor hardware upgrades (e.g. adding the 4th CPU to the DEC 4100, etc), and completing the integration of the two new heterogenous workstations (DEC and SGI) into our AIX cluster. For more responsive archive services, we plan on more fully integrating our high capacity 4mm DLT tape robot into the MCR. Related to this, we hope to pursue development of a simple yet comprehensive, on-line data catalog of our in-house data, using standard database management software.

MODIS Project Activities: Applications
LLoyd P. Queen, James R. Plummer

Satellite Drought Index: Prototype Algorithm Development

A c-code algorithm based on Nemani et al. (1993) and Nemani and Running (1989) surface resistance logic has been completed and is now being run on weekly AVHRR composites delivered by the EROS Data Center. The algorithm outputs values for two landcover products; a Drought Index and a Fire Danger Index. The images are being generated for the eleven western states one time per week. A figure showing the drought product for the first composite period in June 1997 is attached as Figure 1. Statistical summaries of the NDVI and

Surface Temperature (TIR) data used to estimate the indices are shown in Figure 2.

The images are coded with a legend that identifies levels of moisture stress and fire danger, and are then posted to an ftp site. Data posted to the ftp site include picture files in .gif format, AR/INFO-GRID format files, and a metadata text file that provides documentation of the imagery.

The primary targeted users are members of the USDA Forest Service Intermountain Fire Sciences Laboratory (Research) and several National Forests in western Montana and northern Idaho. Additionally, scientists participating in the Upper Midwest Aerospace Consortium are accessing the images. Users from the Consortium include Montana State University, the University of Idaho, North Dakota State University, the University of North Dakota, the University of Wyoming, the South Dakota School of Mines, and South Dakota State University.

Collaborative Activities

Beginning in July 1997 we initiated work on development of a prototype algorithm for fire detection using AVHRR data. We are cooperating with the Fire Chemistry Project at the Intermountain Fire Sciences Lab and researchers at Goddard Space Flight Center (Kaufman, et al., 1996). The intent of this collaboration is to test the logic for the MODIS fire detection product using AVHRR pathfinder data. The current effort is oriented to writing the necessary C-code for the algorithm. When finished, the code will be applied to the AVHRR data stream coming from EROS, and the resultant fire detection images will be posted to our ftp site. All drought and fire products generated through our program will be documented as per FGDC standards; with the long term goal of prototyping the FGDC-supported system-wide interface layer (SWIL).

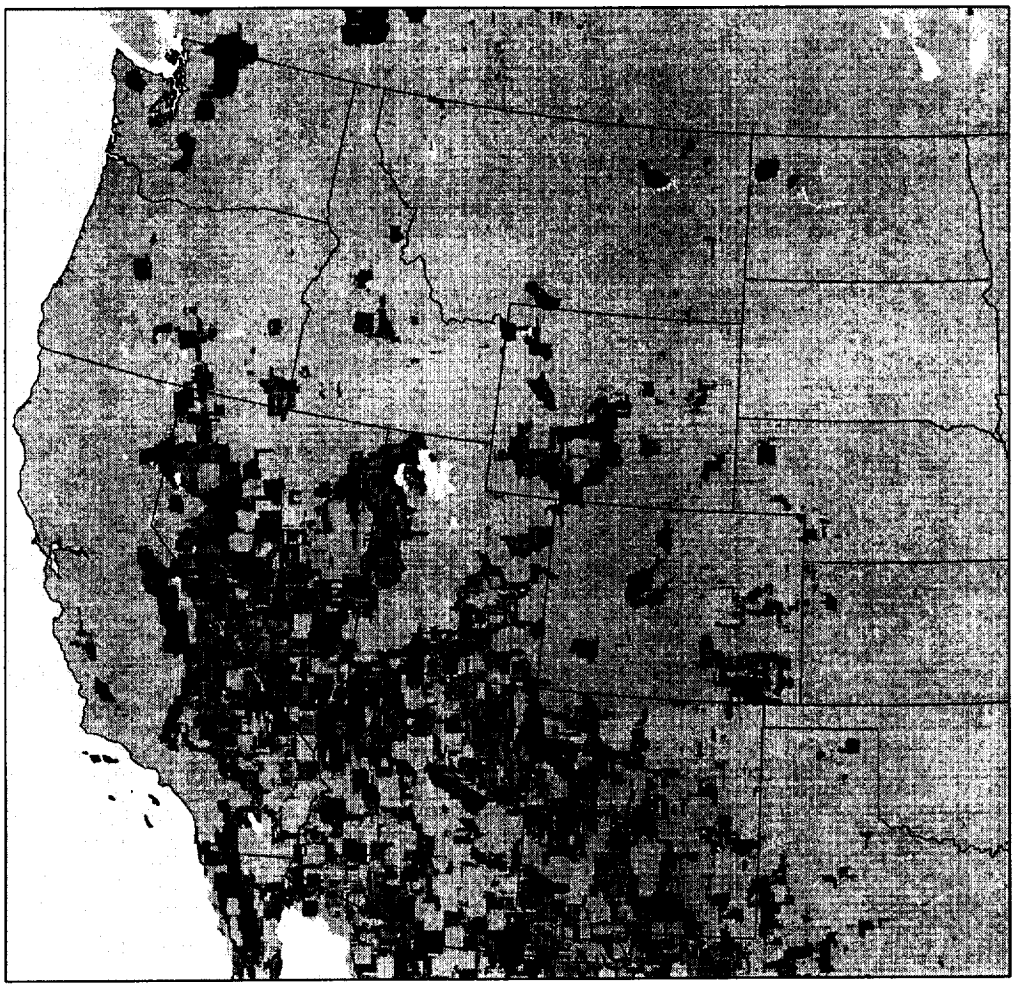
Ongoing Activities

Now that initial implementation is underway, several development activities are ongoing. These include derivation of long-term normal (empirical) scores for fire and drought products. Expected ranges in score variability will be determined by processing AVHRR composites from 1994 (a drought year) and 1993 (a wet year). These ranges will assist in standardizing legends and will be used to convert index scores to Palmer Drought Index (PDI) values.

Secondly, we are developing variants of the existing algorithm that allow the user to change the convolution window size and lag used to generate the resistance scores. Additionally, we are exploring the use of landcover maps (EROS land-cover characterization product) to stratify the AVHRR composites prior to model execution. This will intensify the sampling and estimation of drought condition for specific biome types.

SATELLITE FIRE DANGER INDEX

Derived from June 20-26 1997 AVHRR Composite Data



Numerical Terradynamic Simulation Group

Fire Danger Level

Low Medium High

Remote Sensing Program

School of Forestry
University of Montana

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Publications and Presentations

"Enhanced Algorithms for Remote Sensing of Biomass Burning." Plummer, J., L. Queen, S. Running, W. Hao, and D. Ward. Poster presented to MT/ID GIS User's Conference. Bozeman, MT. April, 1997.